Table of Contents

Message from the General Chair and the Program Co-Chairs ........................................... xiii
Organizing Committee ........................................................................................................... xv
Steering Committee ............................................................................................................. xvii
Program Committee ............................................................................................................ xviii

Research Track

On the Relation of Test Smells to Software Code Quality ..................................................... 1
Davide Spadini (Delft University of Technology), Fabio Palomba (University of Zurich), Andy Zaidman (Delft University of Technology), Magiel Bruntink (Software Improvement Group), and Alberto Bacchelli (University of Zurich)

Why are Features Deprecated? An Investigation Into the Motivation Behind Deprecation .......... 13
Anand Ashok Sawant (Delft University of Technology), Guangze Huang (Delft University of Technology), Gabriel Vilen (Delft University of Technology), Stefan Stojkovski (Delft University of Technology), and Alberto Bacchelli (University of Zurich)

A Large-Scale Empirical Study on Linguistic Antipatterns Affecting APIs ............................. 25
Emad Aghajani (Università della Svizzera italiana), Csaba Nagy (Università della Svizzera italiana), Gabriele Bavota (Università della Svizzera italiana), and Michele Lanza (Università della Svizzera italiana)

Reproducible Interference-Aware Mobile Testing ................................................................. 36
Weilun Xiong (Shanghai Jiao Tong University), Shihao Chen (Shanghai Jiao Tong University), Yuning Zhang (Shanghai Jiao Tong University), Mingyuan Xia (Shanghai Jiao Tong University), and Zhengwei Qi (Shanghai Jiao Tong University)

DRLgencert: Deep Learning-Based Automated Testing of Certificate Verification in SSL/TLS Implementations .............................................................. 48
Chao Chen (Shandong University), Wenrui Diao (Jinan University), Yingpei Zeng (China Mobile (Hangzhou) Information Technology Co., Ltd.), Shanqing Guo (Shandong University), and Chengyu Hu (Shandong University)

Combining Search-Based Testing and Dynamic Symbolic Execution by Evolvability Metric ........ 59
Ziming Zhu (Institute of Software Chinese Academy of Sciences, University of Chinese Academy of Sciences), Li Jiao (Institute of Software, Chinese Academy of Sciences), and Xiong Xu (Institute of Software Chinese Academy of Sciences)
Statistical Translation of English Texts to API Code Templates ........................................... 194
Anh Nguyen (Axon US Corp), Peter Rigby (Concordia University, Canada), Thanh Nguyen (Iowa State University), Dharani Palani (Concordia University, Canada), Mark Karanfil (Concordia University), and Tien Nguyen (University of Texas at Dallas, USA)

AudioHighlight: Code Skimming for Blind Programmers .................................................. 206
Ameer Armaly (Google), Paige Rodegly (Clemson University), and Collin McMillan (University of Notre Dame)

Gistable: Evaluating the Executability of Python Code Snippets on GitHub .......................... 217
Eric Horton (North Carolina State University) and Chris Parnin (North Carolina State University)

How do Multiple Pull Requests Change the Same Code: A Study of Competing Pull Requests in GitHub ........................................................................................................... 228
Xin Zhang (Wuhan University), Yang Chen (Wuhan University), Yongfeng Gu (Wuhan University), Weiqin Zou (Nanjing University), Xiaoyuan Xie (Wuhan University), Xiangyang Jia (Wuhan University), and Jifeng Xuan (Wuhan University)

Assessing Test Case Prioritization on Real Faults and Mutants ........................................... 240
Qi Luo (College of William & Mary), Kevin Moran (College of), Denys Poshyvanyk (College), and Massimiliano Di Penta (University of Sannio)

Predicting Higher Order Structural Feature Interactions in Variable Systems ....................... 252
Stefan Fischer (Johannes Kepler University), Lukas Linsbauer (Johannes Kepler University), Alexander Egyed (Johannes Kepler University), and Roberto Erick Lopez-Herrejon (Ecole de Technologie Superieure Montreal)

Generating Accurate and Compact Edit Scripts Using Tree Differencing .......................... 264
Veit Frick (Alpen-Adria-Universität Klagenfurt), Thomas Grassauer (Alpen-Adria-Universität Klagenfurt), Fabian Beck (University of Duisburg-Essen), and Martin Pinzger (Alpen-Adria-Universität Klagenfurt)

A Closer Look at Real-World Patches .................................................................................. 275
Kui Liu (SnT, University of Luxembourg), Dongsun Kim (SnT, University of Luxembourg), Anil Koyuncu (SnT, University of Luxembourg), Li Li (Monash University), Tegawendé F. Bissyandé (SnT, University of Luxembourg), and Yves Le Traon (SnT, University of Luxembourg)

An Empirical Study of Multi-entity Changes in Real Bug Fixes ......................................... 287
Ye Wang (Virginia Tech), Na Meng (Virginia Tech), and Hao Zhong (Shanghai Jiao Tong University)

A Conceptual Replication Study on Bugs that Get Fixed in Open Source Software .............. 299
Haoren Wang (Wichita State University) and Huzefa Kagdi (Wichita State University)

Automatic Test Smell Detection Using Information Retrieval Techniques .......................... 311
Fabio Palomba (University of Zurich), Andy Zaidman (Delft University of Technology), and Andrea De Lucia (University of Salerno)

RegionDroid: A Tool for Detecting Android Application Repackaging Based on Runtime UI Region Features ............................................................................................................ 323
Shengtao Yue (Nanjing University), Qingwei Sun (Nanjing University), Jun Ma (Nanjing University), Xianping Tao (Nanjing University), Chang Xu (Nanjing University), and Jian Lu (Nanjing University)
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>How Maintainability Issues of Android Apps Evolve</td>
<td>334</td>
</tr>
<tr>
<td>Ivano Malavolta (Vrije Universiteit Amsterdam), Roberto Verdecchia</td>
<td></td>
</tr>
<tr>
<td>(Gran Sasso Science Institute and Vrije Universiteit Amsterdam),</td>
<td></td>
</tr>
<tr>
<td>Bojan Filipovic (Vrije Universiteit Amsterdam), Magiel Bruntink (</td>
<td></td>
</tr>
<tr>
<td>Software Improvement Group (SIG)), and Patricia Lago (Vrije Universiteit</td>
<td></td>
</tr>
<tr>
<td>Amsterdam)</td>
<td></td>
</tr>
<tr>
<td>Studying Permission Related Issues in Android Wearable Apps</td>
<td>345</td>
</tr>
<tr>
<td>Suhaib Mujahid (Concordia University), Rabe Abdalkareem (Concordia</td>
<td></td>
</tr>
<tr>
<td>University), and Emad Shihab (Concordia University)</td>
<td></td>
</tr>
<tr>
<td>Efficient, Evolutionary Security Analysis of Interacting Android Apps</td>
<td>357</td>
</tr>
<tr>
<td>Hamid Bagheri (University of Nebraska-Lincoln), Jianghao Wang</td>
<td></td>
</tr>
<tr>
<td>(University of Nebraska-Lincoln), Jarod Aerts (University of</td>
<td></td>
</tr>
<tr>
<td>Nebraska-Lincoln), and Sam Malek (University of California, Irvine)</td>
<td></td>
</tr>
<tr>
<td>Automatic Traceability Maintenance via Machine Learning Classification</td>
<td>369</td>
</tr>
<tr>
<td>Chris Mills (Florida State University), and Sonia Haiduc (Florida</td>
<td></td>
</tr>
<tr>
<td>State University)</td>
<td></td>
</tr>
<tr>
<td>Are Bug Reports Enough for Text Retrieval-Based Bug Localization?</td>
<td>381</td>
</tr>
<tr>
<td>Chris Mills (Florida State University), Jevgenija Pantuchina</td>
<td></td>
</tr>
<tr>
<td>(Universita della Svizzera italiana), Esteban Parra (Florida State</td>
<td></td>
</tr>
<tr>
<td>University), Gabriele Bavota (Universita della Svizzera italiana),</td>
<td></td>
</tr>
<tr>
<td>and Sonia Haiduc (Florida State University)</td>
<td></td>
</tr>
<tr>
<td>Linking Source Code to Untangled Change Intents</td>
<td>393</td>
</tr>
<tr>
<td>Xiaoyu Liu (Southern Methodist University), LiGuo Huang (Southern</td>
<td></td>
</tr>
<tr>
<td>Methodist University), Chuanyi Liu (Nanjing University), and Vincent</td>
<td></td>
</tr>
<tr>
<td>Ng (University of Texas at Dallas)</td>
<td></td>
</tr>
<tr>
<td>On the Evolution of Technical Lag in the npm Package Dependency</td>
<td>404</td>
</tr>
<tr>
<td>Alexandre Decan (University of Mons), Tom Mens (University of Mons),</td>
<td></td>
</tr>
<tr>
<td>and Eleni Constantinou (University of Mons)</td>
<td></td>
</tr>
<tr>
<td>Embracing Technical Debt, from a Startup Company Perspective</td>
<td>415</td>
</tr>
<tr>
<td>Terese Besker (Chalmers University of Technology Göteborg), Antonio</td>
<td></td>
</tr>
<tr>
<td>Martini (CA Technologies Strategic Research Team, Barcelona and</td>
<td></td>
</tr>
<tr>
<td>Programming and Software Engineering, University of Oslo), Rumesh</td>
<td></td>
</tr>
<tr>
<td>Edirisooriya Lokuje (The University of Auckland), Kelly Blincoe (The</td>
<td></td>
</tr>
<tr>
<td>University of Auckland), and Jan Bosch (Chalmers University of</td>
<td></td>
</tr>
<tr>
<td>Technology Göteborg)</td>
<td></td>
</tr>
<tr>
<td>A Reflexive and Automated Approach to Syntactic Pattern Matching in</td>
<td>426</td>
</tr>
<tr>
<td>Code Transformations ...</td>
<td></td>
</tr>
<tr>
<td>Jason Lecerf (CEA-LIST), John Brant (RefactoryWorkers), Thierry</td>
<td></td>
</tr>
<tr>
<td>Goubier (CEA-LIST), and Stéphane Ducasse (Inria Lille Nord Europe)</td>
<td></td>
</tr>
<tr>
<td>On the Impact of Tokenizer and Parameters on N-Gram Based Code</td>
<td>437</td>
</tr>
<tr>
<td>Analysis</td>
<td></td>
</tr>
<tr>
<td>Matthieu Jimenez (University of Luxembourg), Cordy Maxime (University</td>
<td></td>
</tr>
<tr>
<td>of Namur), Yves Le Traon (University of Luxembourg), and Mike</td>
<td></td>
</tr>
<tr>
<td>Papadakis (University of Luxembourg)</td>
<td></td>
</tr>
<tr>
<td>Beyond Metadata: Code-Centric and Usage-Based Analysis of Known</td>
<td>449</td>
</tr>
<tr>
<td>Vulnerabilities in Open-Source Software</td>
<td></td>
</tr>
<tr>
<td>Serena Elisa Ponta (SAP Security Research), Henrik Plate (SAP Security</td>
<td></td>
</tr>
<tr>
<td>Research), and Antonino Sabetta (SAP Security Research)</td>
<td></td>
</tr>
<tr>
<td>Adapting Neural Text Classification for Improved Software</td>
<td>461</td>
</tr>
<tr>
<td>Categorization</td>
<td></td>
</tr>
<tr>
<td>Alexander LeClair (The University of Notre Dame), Zachary Eberhart</td>
<td></td>
</tr>
<tr>
<td>(The University of Notre Dame), and Collin McMillan (The University</td>
<td></td>
</tr>
<tr>
<td>of Notre Dame)</td>
<td></td>
</tr>
</tbody>
</table>
Effective Reformulation of Query for Code Search Using Crowdsourced Knowledge and Extra-Large Data Analytics
Mohammad Masudur Rahman (University of Saskatchewan) and Chanchal Roy (University of Saskatchewan)

Search-Based Scheduling of Experiments in Continuous Deployment
Gerald Schermann (University of Zurich) and Philipp Leitner (Chalmers | University of Gothenburg)

Understanding, Debugging, and Optimizing Distributed Software Builds: A Design Study
Carlene Lebeuf (University of Victoria), Elena Voyloshnikova (Microsoft), Kim Herzig (Microsoft), and Margaret-Anne Storey (University of Victoria)

Threats of Aggregating Software Repository Data
Martin P. Robillard (McGill University), Mathieu Nassif (McGill University), and Shane McIntosh (McGill University)

NIER Track
Communicative Intention in Code Review Questions
Felipe Ebert (Federal University of Pernambuco), Fernando Castor (Federal University of Pernambuco), Nicole Novielli (Dipartimento di Informatica, University of Bari), and Alexander Serebrenik (Eindhoven University of Technology)

On the Value of Bug Reports for Retrieval-Based Bug Localization
Dawn Lawrie (Loyola University Maryland) and Dave Binkley (Loyola University Maryland)

Semi-Automated Feature Traceability with Embedded Annotations
Hadil Abukwaik (ABB Corporate Research Center), Andreas Burger (ABB Corporate Research Center), Berima Kweku Andam (Chalmers University of Technology), and Thorsten Berger (Chalmers | University of Gothenburg)

An Empirical Study of Flaky Tests in Android Apps
Swapna Thorve (Virginia Tech), Chandani Sreshtha (Virginia Tech), and Na Meng (Virginia Tech)

Toward Automatic Summarization of Arbitrary Java Statements for Novice Programmers
Mohammed Hassan (Drew University) and Emily Hill (Drew University)

Towards Feature Envy Design Flaw Detection at Block Level
Árpád Kiss (Politehnica University of Timisoara) and Petru Florin Mihaicu (Politehnica University of Timisoara)

Automated Extraction of Augmented Models for Android Apps
Santiago Liñán (Universidad de los Andes), Laura Bello-Jiménez (Universidad de los Andes), María Arévalo (Universidad de los Andes), and Mario Linares-Vásquez (Universidad de los Andes)

An Empirical Study on the Effect of Dynamic Slicing on Automated Program Repair Efficiency
Anbang Guo (National University of Defense Technology), Xiaoguang Mao (National University of Defense Technology), Deheng Yang (National University of Defense Technology), and Shangwen Wang (National University of Defense Technology)
Towards Smoother Library Migrations: A Look at Vulnerable Dependency Migrations at Function Level for npm JavaScript Packages ................................................................. 559
  Rodrigo Elizalde Zapata (Nara Institute of Science and Technology), Raula Gaikovina Kula (Nara Institute of Science and Technology), Bodin Chinthanet (Nara Institute of Science and Technology), Takashi Ishio (Nara Institute of Science and Technology), Kenichi Matsumoto (Nara Institute of Science and Technology), and Akinori Ihara (Wakayama University)

Continuous Refactoring in CI: A Preliminary Study on the Perceived Advantages and Barriers .... 564
  Carmine Vassallo (University of Zurich), Fabio Palomba (University of Zurich), and Harald C. Gall (University of Zurich)

Industry Track

Reducing Code Duplication by Identifying Fresh Domain Abstractions ........................................ 569
  Steven Klusener (ESI (TNO)), Arjan Mooij (ESI (TNO)), Jeroen Ketema (ESI (TNO)), and Hans Van Wezep (Philips Healthcare)

A Practical Approach to the Automatic Classification of Security-Relevant Commits ....................... 579
  Antonino Sabetta (SAP Security Research) and Michele Bezzi (SAP Security Research)

COBOL to Java and Newspapers Still Get Delivered ........................................................................ 583

An Experience Report of the API Evolution and Maintenance for Software Platforms ...................... 587
  Hobum Kwon (Samsung Electronics), Juwon Ahn (Samsung Electronics), Sunggyu Choi (Samsung Electronics), Jakub Siewierski (Samsung Electronics), Piotr Kosko (Samsung Electronics), and Piotr Szydelko (Samsung Electronics)

Cloned Buggy Code Detection in Practice Using Normalized Compression Distance ...................... 591
  Takashi Ishio (Nara Institute of Science and Technology), Naoto Maeda (NEC Corporation), Kensuke Shibuya (NEC Corporation), and Katsuro Inoue (Osaka University)

Stereo: Editing Clones Refactored as Code Generators ...................................................................... 595
  Nic Volanschi (Metaware Technologies & Inria Bordeaux)

Understanding the Role of Reporting in Work Item Tracking Systems for Software Development: An Industrial Case Study ................................................................. 605
  Pavneet Singh Kochhar (Singapore Management University), Stanislaw Swierc (Microsoft Corporation), Trevor Carnahan (Microsoft Corporation), Hitesh Sajnani (Microsoft Corporation), and Meiyappan Nagappan (University of Waterloo)

A Qualitative Study of Variability Management of Control Software for Industrial Automation Systems .............................................................................................................. 615
  Juliane Fischer (Technical University of Munich), Safa Bougouffa (Technical University of Munich), Alexander Schlie (Technical University of Braunschweig), Ina Schaefer (Technical University of Braunschweig), and Birgit Vogel-Heuser (Technical University of Munich)
Clone-Based Variability Management in the Android Ecosystem ............................................. 625
John Businge (Mbarara University of Science and Technology, Uganda), Moses Openja (Mbarara University of Science and Technology, Uganda), Sarah Nadi (Canada University of Alberta), Engineer Bainomugisha (Makerere University, Uganda), and Thorsten Berger (Chalmers | University of Gothenburg)

Relational Database Schema Evolution: An Industrial Case Study ........................................... 635
Julien Delplanque (University of Lille), Anne Etien (University of Lille), Nicolas Anquetil (University of Lille), and Olivier Auverlot (CRIStAL laboratory)

Detecting and Predicting Evolution in Spreadsheets - A Case Study in an Energy Network Company ................................................................................................................................. 645
Bas Jansen (Delft University of Technology), Felienne Hermans (Delft University of Technology), and Edwin Tazelaar (Alliander)

Aligning Technical Debt Prioritization with Business Objectives: A Multiple-Case Study .......... 655
Rodrigo Rebouças de Almeida (Federal University of Paraíba), Uirá Kulesza (Federal University of Rio Grande do Norte), Christoph Treude (University of Adelaide), D’angellys Cavalcanti Feitosa (Conductor), and Aliandro Higino Guedes Lima (Dataprev)

Software Process Analysis Methodology – A Methodology Based on Lessons Learned in Embracing Legacy Software ........................................................................................................ 665
Maikel Leemans (Eindhoven University of Technology), Wil M. P. van der Aalst (RWTH Aachen University), Mark G. J. van den Brand (Eindhoven University of Technology), Ramon R. H. Schifflers (ASML, Veldhoven, The Netherlands), and Leonard Lensink (Embedded Systems Innovation, Eindhoven, The Netherlands)

Mainframe Migration Based on Screen Scraping ......................................................................... 675
Sergio Flores-Ruiz (itesra GmbH), Ricardo Perez-Castillo (Information Systems and Technology Institute (ITSI)), Christoph Domann (itesra GmbH), and Simona Puica (itesra GmbH)

BLIMP Tracer: Integrating Build Impact Analysis with Code Review ........................................... 685
Ruiyin Wen (McGill University), David Gilbert (Dell EMC Corporation), Michael G. Roche (Dell EMC Corporation), and Shane McIntosh (McGill University)

Tool Demo Track

Developers’ Game: A Preliminary Study Concerning a Tool for Automated Developers Assessment ...................................................................................................................................... 695
Wojciech Frcz (AGH University of Science and Technology, Kraków, Poland) and Jacek Dajda (AGH University of Science and Technology, Kraków, Poland)

GemChecker: Reporting on the Status of Gems in Ruby on Rails Projects .................................. 700
Jamie Cleare (University of Portsmouth) and Claudia Iacob (University of Portsmouth)

DiffViz: A Diff Algorithm Independent Visualization Tool for Edit Scripts ................................. 705
Veit Frick (Alpen-Adria-Universität Klagenfurt), Christoph Wedenig (Alpen-Adria-Universität Klagenfurt), and Martin Pinzger (Alpen-Adria-Universität Klagenfurt)
Artifacts Track

Replication Package for "Threats of Aggregating Software Repository Data" ........................................ 710
Martin P. Robillard (McGill University), Mathieu Nassif (McGill University), and Shane McIntosh (McGill University)

Artefact: An R Implementation of the AutoSpearman Function ................................................................. 711
Jirayus Jiarpakdee (The University of Adelaide), Chakkrit Tantithamthavorn (The University of Adelaide), and Christoph Treude (The University of Adelaide)

Two Datasets for Sentiment Analysis in Software Engineering .................................................................................. 712
Bin Lin (Università della Svizzera italiana (USI)), Fiorella Zampetti (University of Sannio), Rocco Oliveto (University of Molise), Massimiliano Di Penta (University of Sannio), Michele Lanza (Università della Svizzera italiana (USI)), and Gabriele Bavota (Università della Svizzera italiana (USI))

TraceLab Components for Generating Speech Act Types in Developer Question/Answer Conversations ......................................................................................................................... 713
Rrezarta Krasniqi (University of Notre Dame) and Collin McMillan (University of Notre Dame)

NLP2API: Query Reformulation for Code Search Using Crowdsourced Knowledge and Extra-Large Data Analytics ......................................................................................................................... 714
Mohammad Masudur Rahman (University of Saskatchewan) and Chanchal Roy (University of Saskatchewan)

TUNA: TUning Naturalness-Based Analysis ........................................................................................................... 715
Matthieu Jimenez (University of Luxembourg), Cordy Maxime (University of Namur), Yves Le Traon (University of Luxembourg), and Mike Papadakis (University of Luxembourg)

Doctoral Symposium

Predicting Software Maintainability in Object-Oriented Systems Using Ensemble Techniques .......... 716
Hadeel Alsolai (Princess Nourah Bint Abdulrahman University; University of Strathclyde)

Methods and Tools for Focusing and Prioritizing the Testing Effort ................................................................. 722
Dario Di Nucci (Vrije Universiteit Brussel)

Context-Aware Software Documentation ............................................................................................................. 727
Emad Aghajani (Università della Svizzera italiana)

Team Maturity in Agile Software Development: The Impact on Productivity ..................................................... 732
Sandra L. Ramírez-Mora (National Autonomous University of Mexico) and Hanna Oktaba (National Autonomous University of Mexico)

Dead Code ...................................................................................................................................................... 737
Simone Romano (University of Basilicata)

Integrating Runtime Values with Source Code to Facilitate Program Comprehension .................................... 743
Matúš Sulír (Technical University of Košice)

Automating Software Development for Mobile Computing Platforms .......................................................... 749
Kevin Moran (College of William & Mary)

Logical Dependencies between Classes: How to Find Them and How to Use Them? ................................. 755
Adelina Diana Stana (Politehnica University of Timisoara), Ioana Sora (Politehnica University of Timisoara), and Vladimir Cretu (Politehnica University of Timisoara)